**ESA / NASA / NASDA**

**Space Networks Interoperability Panel**

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**RECOMMENDATIONS**

**for**

**International Space Network**

**Ka-Band Interoperability**

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**Revision 1 : June 1995**

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Approved : _____
                     Klaus Lenhart, ESA Co-Chairman


Approved : _____
                     Thomas Ryan, NASA Co-Chairman


Approved : _____
                     Katsuyoshi Arai, NASDA Co-Chairman

The current plans of ESA, NASA and NASDA foresee operational data relay satellite systems in operation around the end of the 1990's, all using the same Ka-band IOL frequency bands :

> 23.12 - 23.55 GHz forward and
> 25.25 - 27.50 GHz return

These recommendations, first signed on behalf of NASA, ESA and NASDA in Tokyo on 2 May 1991, are the result of the SNIP Ka-Band study activity and are hereby approved SNIP technical recommendations for the data relay satellite systems of the three Agencies.

This Revised Recommendation reflects changes since May 1991.

Note   "Notes" following each Recommendation are added to indicate where non-compliance is currently foreseen.

## 1.    Link Budgets

SNIP has studied the link budgets for interoperability between the three systems, based on their declared characteristics, principally :

|  | EIRP towards User S/C | G/T towards User S/C |  |
|---|---|---|---|
| ESA  DRS | 61.3 dBW | 22.3 dB/K | auto-track |
|  | 57.3 dBW | 19.3 dB/K | open-loop pointing |
| NASDA  DRTSS | 61.5 dBW | 26.5 dB/K | auto-track |
|  | 59.0 dBW | 24.0 dB/K | open-loop pointing |
| NASA  TDRS/H,I,J | 63.0 dBW | 26.5 dB/K | auto-track |
|  | 59.5 dBW | 23.0 dB/K | open-loop pointing |

and has concluded that all combinations of user spacecraft and host relay satellite are capable of supporting a useful forward and return interoperability service.

2.      Field of View

SNIP recommends that data relay satellites be able to transmit and receive IOL signals with a minimum conical field of view of $\pm 10°$ about the satellite-to-Earth centre axis.

3.      Forward Link Frequency Framework

SNIP recommends that data relay IOL forward channel centre frequencies be selected from the following :

> 23.205 GHz
> 23.265 GHz
> 23.325 GHz
> 23.385 GHz
> 23.445 GHz
> 23.505 GHz

SNIP recommends that each data relay satellite shall be able to transmit forward IOL signals on any of the above frequencies, with a minimum bandwidth of 50 MHz.

Note    ESA DRS Satellites are not currently specified to provide the forward IOL frequency at 23.505 GHz, as analyses show that excessive interference may be generated by transmissions in this channel at the beacon frequencies, 23.540 GHz and 23.545 GHz.

4.      Return Link Frequency Framework

SNIP recommends that data relay IOL return link channel centre frequencies be selected from the following :

> 25.600 GHz
> 25.850 GHz
> 26.100 GHz
> 26.350 GHz
> 26.600 GHz
> 26.850 GHz
> 27.100 GHz
> 27.350 GHz

SNIP recommends that each data relay satellite shall be able to receive return IOL signals on any of the above frequencies, with a minimum bandwidth of 225 MHz on all frequencies.

5.    Polarisation

SNIP recommends that data relay satellites and user spacecraft be able to operate either on LHCP or RHCP, with the same polarisation for the selected forward and return IOL frequencies.


Note    The ESA ARTEMIS Satellite will use opposite polarisations for forward and return Ka-band IOLs. However, the ESA DRS Satellites will conform to the above Recommendation.


6.    Polarisation Purity

SNIP recommends that the IOL antenna axial ratio of data relay satellites be not greater than 1.5 dB over the 3 dB beamwidth.


7.    Forward Beacon

SNIP recommends that each relay satellite be able to generate, in the direction of any interoperable-user spacecraft, a reference signal to allow user spacecraft antenna acquisition.

This reference signal may be either an unmodulated carrier, transmitted with the same frequency and polarisation as the user forward IOL signal, or a wide-beam beacon, transmitted on LHCP at one of the following frequencies, selected in coordination with the other SNIP participating Agencies :

> 23.530 GHz
> 23.535 GHz
> 23.540 GHz
> 23.545 GHz

The reference signal EIRP towards the User Spacecraft should be +24 dBW minimum.


Note    The NASA TDRS H, I, J satellites will not provide a wide-beam beacon but will be able to provide for an unmodulated forward signal to be transmitted at the same frequency and polarisation as the user forward IOL signal to allow for user spacecraft antenna acquisition.

8.  Return Signal Tracking

SNIP recommends that relay satellite return-link tracking, if required, should operate on the modulated signal, at the return frequency selected by the user.


9.  Dual-Band IOL Operation

SNIP recommends that all relay satellites be able to provide two-way (forward and return) interoperable IOL service to user spacecraft in both S-band and Ka-band simultaneously.


Note    The ESA ARTEMIS Satellite is able to provide simultaneous S-band and Ka-band return IOL service together with forward service in one band only.


10.  User Spacecraft Tracking

SNIP makes no recommendations for user spacecraft tracking services via interoperable data relay satellites using Ka-band IOLs.


11.  Modulation Scheme

SNIP recommends the use of any of the following modulation schemes for IOL services :

For forward links :
    BPSK, QPSK, UQPSK, with no forward error-correction coding;

For return links :
    BPSK, QPSK, UQPSK, either [with forward error-correction coding  (R=1/2, k=7)] or with no coding.


Note    ESA support of SNIP modulation recommendations is dependent on the availability of suitable ground terminals.

12.    <u>Data Rates</u>

SNIP recommends that each data relay satellite IOL be able to support the following ranges of source data rate :

For forward links :
        100 kbit/s  -  25 Mbit/s  (BPSK and UQPSK)
        100 kbit/s  -  50 Mbit/s  (QPSK)

For return links :
        100 kbit/s  -   75 Mbit/s  (with coding; BPSK, UQPSK)
        100 kbit/s  -  150 Mbit/s  (no coding;   BPSK, UQPSK, QPSK)
        100 kbit/s  -  150 Mbit/s  (with coding; QPSK)


<u>Note</u>   Support of higher return link data rates, above about 30 Mbit/s, will be dependent on the availability of decoder equipment in the ground terminals compatible with the coder in the user spacecraft. Currently, ESA, NASA and NASDA coding guidelines follow different concepts.

However, NASA TDRS H, I, J satellites will provide an alternative channel bandwidth of 650 MHz, NASDA DRTS satellites will provide a channel bandwidth of 300 MHz and ESA ARTEMIS and DRS satellites will provide up to three return channels simultaneously on each IOL.